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Meta-Analysis of Research: Indigenous Knowledge in Physics Teaching and Learning

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Abstract: ***The aim of this research is to analyze physics education research articles based on indigenous knowledge from the period of 2019 - 2023. The focus of the analysis is on the research location, research objectives, research methods, and research findings. The data collection method adopted the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta - Analyses) design, specifically the PRISMA 2020 model, consisting of three steps: identification, screening, and inclusion. The search for articles was conducted using the Publish or Perish (PoP) application directly linked to Google Scholar's metadata search. The total number of articles found was 974. After analyzing the PRISMA 2020 model, this study decided to analyze 11 articles that discussed indigenous knowledge in physics education. The analysis results conclude that the integration of indigenous knowledge in physics education has a positive impact on students.***

Keywords: integration, indigenous knowledge, teaching physics

1. Introduction

An interesting quote from the World Bank states: "Understanding how people and societies acquire and use knowledge is essential for improving people's lives, especially the lives of the poorest" (Hoda Yacoub, 2013). Humans, whether consciously or unconsciously, gather knowledge for two main purposes: survival and development. They try to understand the environment to survive, and they seek reasons to survive beyond intuitive reactions to physical threats. In short, this forms the basis for all knowledge - building activities. Long before the development of modern science, which is still relatively young, indigenous communities had developed their own ways of knowing about survival strategies, as well as ideas about meaning, purpose, and values. Indigenous knowledge provides unique perspectives on the world held by various indigenous communities (Robby Zidny, Jesper Sjöström & Ingo Eilks, 2020). For example, Native Elders say that if you do not take care of plants, talk to them, and interact with them, they will become lonely and leave. If humans lose their local wisdom, they will also lose their land. This kind of knowledge is referred to by Hoda Yacoub as "indigenous knowledge" or "traditional knowledge, " "local knowledge, " "traditional ecological knowledge, " "ethnoecology, " and so on (Hoda Yacoub, 2013). Such knowledge is often seen as contrasting with Western ways of producing, recording, and disseminating knowledge. To modern and sophisticated thinking, it may seem like ancient beliefs without profound truths. However, upon deeper reflection, local knowledge can enhance understanding of agriculture, health, food security, and other natural resource management issues.

One of the major challenges in science education is students' perception that science lessons in secondary schools are uninteresting, not enjoyable, and irrelevant (Anderhag et al., 2016). This is in line with Holbrook (2005), who discusses how science learning is perceived as irrelevant and thus unpopular among students. Just look at the science textbooks circulating in Indonesia; they are uniform and highly irrelevant to the diverse situations and conditions of Indonesian students in various aspects.

The main reason for this loss of perceived relevance is believed to be the lack of connection between science learning and students' daily lives and the wider society (Childs et al., 2015). To enhance the relevance of science education as part of relevant education, science education should be more contextual. It has been stated that the use of contextual physics teaching materials improves students' mastery of concepts (Oktaviani et al., 2017). This is because physics concepts are natural dimensions of the world in which humans exist and coexist (Sithole, 2016). Research by Ng'asike (2011) states that shepherd children find it easier to understand the concept of pressure through examples of camel and goat footprints than using general examples found in science textbooks (physics). These examples are highly contextual to the students' lives. From this research, it can be further concluded that the success and failure of students in science learning are not solely due to cognitive factors but also contextual factors.

Therefore, the design of learning in schools should be balanced and comprehensive. It should strike a balance between content and context and encompass science and various aspects of human life, including social and cultural aspects. To achieve more relevant science teaching and learning and to innovate curriculum development, curriculum development driven by theory and evidence - based science education and appropriate teacher education is greatly needed (Hugerat et al., 2015). Hence, it is important to implement new topics and pedagogies in science teaching and to transform teacher education programs. One source for these new topics is sustainability thinking and action, and the corresponding educational paradigm is called Education for Sustainable Development (ESD) (Burmeister et al., 2012).

Therefore, integrating Indigenous Knowledge in physics education provides an opportunity to bridge the gap between scientific knowledge and local knowledge, while appreciating the richness and cultural diversity within education. This can enhance the relevance, interest, and understanding of physics among students while fostering respect for the culture and knowledge existing in society. Physics learning that incorporates Indigenous Knowledge can stimulate critical thinking, creativity, and innovation in students as they seek solutions to physics and environmental problems. That is why this research study focuses on the analysis of integrating indigenous knowledge in physics education. Through this study, we can understand the current trends of indigenous knowledge research in physics education.

2. Method

This research examines the scope of indigenous knowledge in physics education. A systematic review was conducted using the PRISMA (Preferred Items for Systematic Review and Meta - Analysis) approach, specifically the PRISMA 2020 model, through three stages: identification, screening, and inclusion. A total of 974 articles were found from the period of 2019 to 2023. This study decided to review 11 articles based on the three stages of PRISMA 2020.

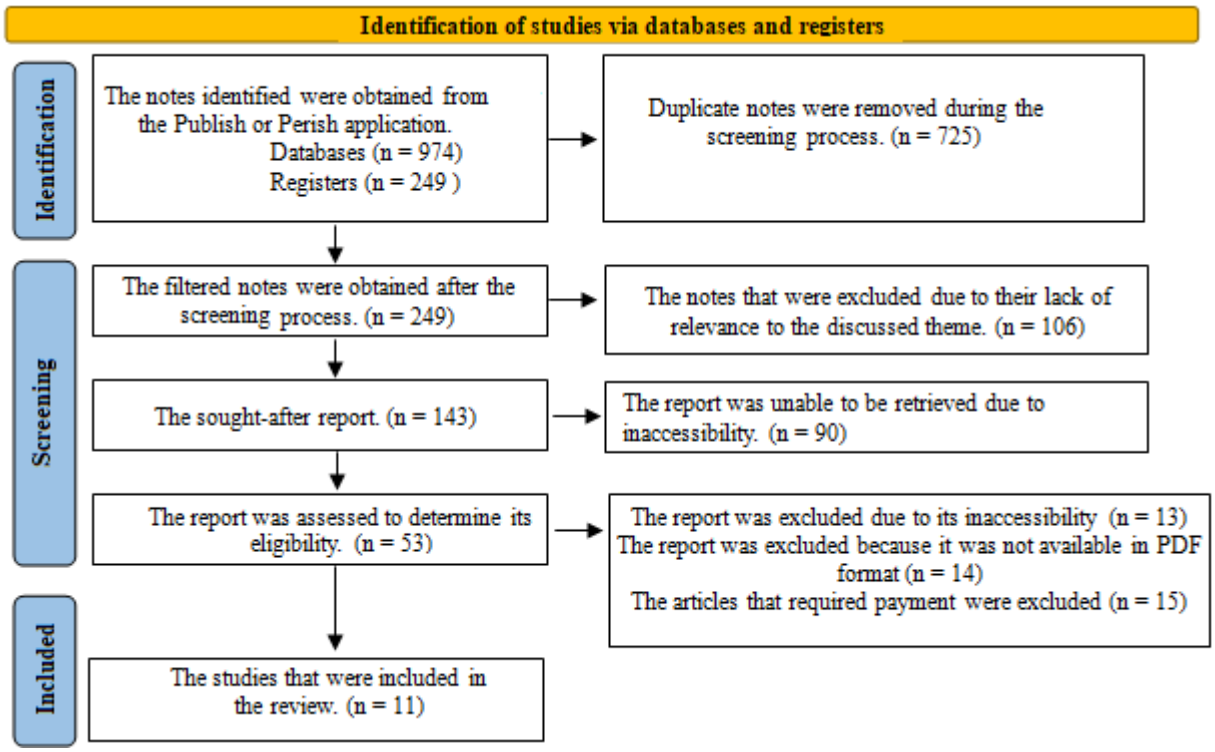

Figure 1: PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only (http: //www.prisma - statement. org/PRISMAStatement/FlowDiagram).

3. Result/ Discussion

The article search was conducted using the *Publish or Perish* (PoP) application, which was linked directly to the Google Scholar search engine. The search was conducted for articles published between 2019 and 2023. A total of 974 articles were obtained using the keywords "indigenous knowledge" and "physics education. " Based on the four - step analysis, 11 articles that met the criteria for analysis were identified and presented in Table 1.

No	Penulis	Judul	Th	Lokasi	Tujuan	Metode	Hasil Penelitian
1	KC Moro, WJSM Billote	Integrating Ivatan Indigenous Games to Learning Module in Physics: Its Effect to Student Understanding, Motivation, Attitude, and Scientific Sublime	2023	Batanes, Philippines	Furthermore, the study aimed to reintroduce the Ivatan indigenous games to the younger Ivatan learners of Batanes, Philippines, through physics, in an attempt to help preserve its culture and traditions by integrating it to the teaching - learning process.	This research study employed quasi - experimental research design as it focused on the effect of the pedagogical intervention. Specifically, the development of the gamebased learning module utilized the Analysis – Design –	A thirty - item test, the Physics Motivation Questionnaire II, the Colorado learning attitudes toward science survey, and open - ended journal questions were the instruments used to test the module's effectiveness. Results revealed a significant difference (Mdiff = −2.65) in student understanding with a 0.31 small effect size; students' motivation revealed a significant difference (Mdiff = −0.91) with a large effect size of 0.86; and student attitudes revealed a significant difference (Mdiff = −0.44) with a medium effect size of 0.78. The correlation between understanding, motivation, and attitudes (rund - mot = 0.65; rund - att = 0.83; rmot - att = 0.72)

						Development – Implement – Evaluate (ADDIE) model.	was all positive uphill relationships. Finally, responses from the journal revealed that the most common feedback among learners was the extreme feeling of happiness while generating only 5% of sublime feelings such as extreme awe/amazement/overwhelmed. These results revealed that the developed material effectively improved students' understanding, motivation, and altering attitudes to a favorable state while realizing that it is unsuccessful in fostering scientific sublime.
2	H Nuroso, S Sudarmin	Identification of indigenous science in the brick - making process through ethnoscience study	2019	Penggaron village of Semarang city and in Welahan village of Jepara.	This study aims to find indigenous science in making bricks. In the brick - making process there are concepts of science used for generations obtained through local wisdom.	The method employed in this research is descriptive qualitative.	The result of the research indicates that the indigenous science is in the process of making bricks which includes materials composing, printing, drying, burning and brick quality testing. These findings can be integrated in the course of environmental physics.
3	RD Handayani, I Wilujeng, ZK Prasetyo	An identification of *Indigenous Knowledge* related to the thermal physics concept	2019	Samin community in Blor	The purpose of this research was to identify *Indigenous Knowledge* that related to the thermal physics concepts an incorporated into school curricula	A qualitative approach was used in this study.	The results indicated that *Indigenous Knowledge* is related to the concept of thermal physics in the form of experience and beliefs to preserve traditions and cultural values in their daily lives. In this case, indigenous physics is a way of knowing and way of life.
4	Y Ratnasari	Exploring *Indigenous Knowledge* of the concepts of Physics in the Northern Coast, Indonesia	2020	Northern Coast of Java, Indonesia	This study was conducted to explore the integration of the concepts of Physics and *Indigenous Knowledge* in the Northern Coast of Java, Indonesia	s qualitative study	Some of the physical concepts discussed include change of state, conductors and insulators and heat transfers. Experts have confirmed conformity between *Indigenous Knowledge* and the concept of Physics, but some beliefs have been passed through generations. Teachers' understanding of *Indigenous Knowledge* was limited to a theory, resulting in less appropriate facts from actual conditions in the community which caused misconceptions.
5	WN Azmy, H Kuswanto	Comic Indigenous (Bola Kasti) Based Android: The Development Integrate Problem Based Learning	2021	Yogyakarta, Sleman, Indonesia	The research aims to determine the feasibility of indigenous comics (ball kasti) based on android integrated problem based learning (PBL) in physics learning.	Media development using the 4D model which consists of define, develop, design, and disseminate	This is evidenced by the results of the product on the material and media aspects which are included in the very good category, with the proportion of the successive average values of 93.08% and 93.42%. And also the results of student responses that are included in the good category with an average proportion of 95.92% production results.
6	P Parmin, P Nuangchalerm	Exploring the *Indigenous Knowledge* of Java North Coast Community (Pantura) using the science integrated learning (SIL) model for science content	2019	Java North Coast Community (Pantura)	The research explores the *Indigenous Knowledge* of Java north coast community in Java Island, Indonesia	The method adopted is descriptive research	It concludes that the explored *Indigenous Knowledge* using the SIL model is effective for science content development. The exploration results are useful for developing science content
7	RF Sidik, WP Hadi	Reconstruction of Salt Farmers Indigenous Science into Scientific	2019	Surabaya	This study was aimed to reconstruct science society into scientific	The method of this study was qualitative descriptive with retrieval of data	The result showed that there were eight indigenous science from the salt production which could be recontructed into scientific knowledge

		Knowledge in The Salt Production Process			knowledge in production process of salt.	through direct observation, questionnaries, and interviews	
8	ANW Priyadi, H Kuswanto	Development of Comics Work and Energy Assisted Android Based on Indigenous in Wonogiri	2021	Wonogiri	This research aims to determine the feasibility of an comics work and energy assisted android based on indigenous in Wonogiri	This research used the model of development 4D (define, design, development, and disseminate).	The results of instrument validation by the validator are included in the very good category. Evaluation of expert and practitioner validators on products and lesson plans is included in the very good category. Students' response to the comics developed is good. Based on these results, the comic products developed are feasible for use in learning physics, work materials and energy
9	SN Izzah, S Sudarmin, APB Prasetyo	Identification of the indigenous science concepts in the batik - manufacturing process to develop STEM integrated ethnoscience learning	2020	Pekalongan	The aim of the study was to identify the scientific concept in the batik manufacturing processes as learning resources for developing science	The research method was one of qualitative ethnographic studies.	The results showed that in the process of batik - manufacturing by indigenous people in Pekalongan, the concept of science was successfully identified and related to science teaching learning for junior high schools. Furthermore, these scientific concepts were integrated into science learning using the Science, Technology, Engineering and Mathematics (STEM) approach
10	L Heliawati, L Lidiawati	Ethnochemistry - based adobe flash learning media using *Indigenous Knowledge* to improve students' scientific literacy	2022	Bogor	This study aims to measure the effectiveness of using ethnochemistry - based Adobe Flash learning media using *Indigenous Knowledge* on scientific literacy	The study used a quasi - experimental method	The study concludes that applying ethnochemistry - based Adobe Flash learning media on secondary metabolites is effective for students' scientific literacy. Thus, it could be excluded that interactive media can support students' learning and improve scientific literacy
11	P Parmin, M Taufiq	The Mapping of *Indigenous Knowledge* of People at 3T (Frontier, Outermost, and Least Developed) Regions as an Ethnoscience Study	2020	Semarang,	The Mapping of *Indigenous Knowledge* of People at 3T (Frontier, Outermost, and Least Developed) Regions as an Ethnoscience Study	This research employed a qualitative research approach through a descriptive method in which an experimental method was performed for mapping the indigenous knowledge.	The mapping results were followed by confirming the opinions of prospective science teachers obtained by 85 % of 54 students who were interested in this finding as a study of ethnocentric The research concluded that the *Indigenous Knowledge* of people in 3T regions are unique and required to be further examined scientifically and could be reviewed as a source for Ethnoscience course. This research recommendation is that in science learning, especially in the 3T region should pay attention to efforts to change traditional knowledge into scientific knowledge through integrating the mapping of *Indigenous Knowledge* as the content of ethnoscience.

The focus of the analysis in this study includes the following: Research Location, Research Objectives, Research Methods, and Research Findings. Based on the data collected from this research, it was found that physics education research based on indigenous knowledge from the period of 2019 - 2023 was only conducted in two countries, namely the Philippines and Indonesia, as shown in the following figure.

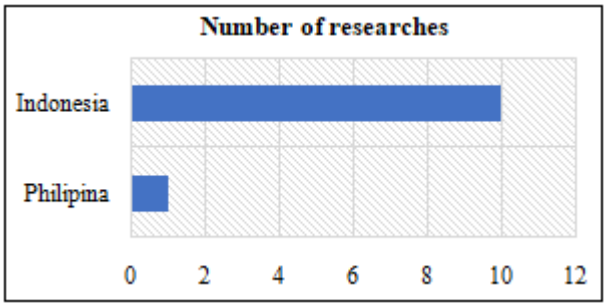

Figure 1: Universal Distribution of Locations

Physics education research based on indigenous knowledge from the period of 2019 - 2023 in Indonesia was only conducted in four provinces out of a total of 38 provinces.

These provinces include Central Java, East Java, West Java, and Yogyakarta Special Region.

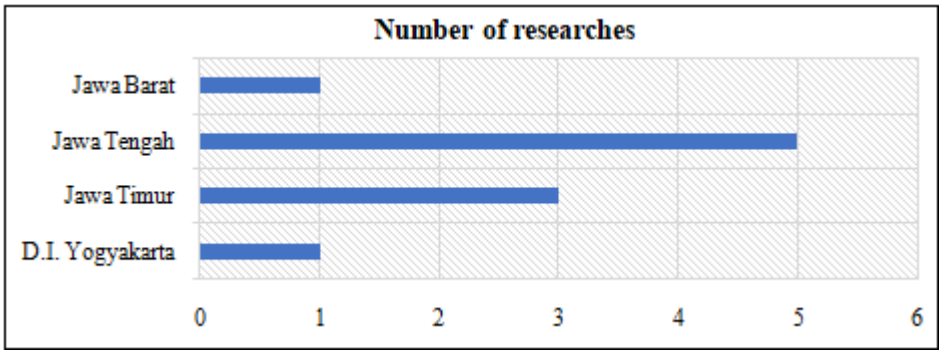

Figure 2: Distribution of Research in Indonesia

Figure 2 provides information that the number of physics education research based on indigenous knowledge is still very minimal during the period of 2019 - 2023. Its distribution is not evenly spread across all regions in Indonesia. This presents an opportunity for future researchers to conduct similar studies in other regions of Indonesia, especially in East Nusa Tenggara Province. Meanwhile, the potential of indigenous knowledge in various regions in Indonesia is diverse and holds great potential for the development of physics education in schools. Indigenous knowledge - based learning is one contextual approach that can enhance students' understanding of physics concepts (Oktaviani, W. et al., 2017).

Research objectives

The objective of this study is to explore the research objectives in this investigation, which is useful for assessing the contribution of research to physics education. Among the 11 analyzed articles, the majority of the objectives contribute to physics education. However, there is one research objective from Nuroso et al. (2019) that is not clearly stated, which is to discover the natural science in brick making. According to the author, this objective does not clearly depict the quality variables of physics education that will be enhanced through the research.

Research Methodology

Table 1 provides an overview of the diversity of research methods employed by researchers. After analyzing the 11 articles, several methods were identified, including Research and Development, qualitative descriptive, and Quasi - experimental. The frequency of method usage by researchers can be depicted as follows (Figure 3):

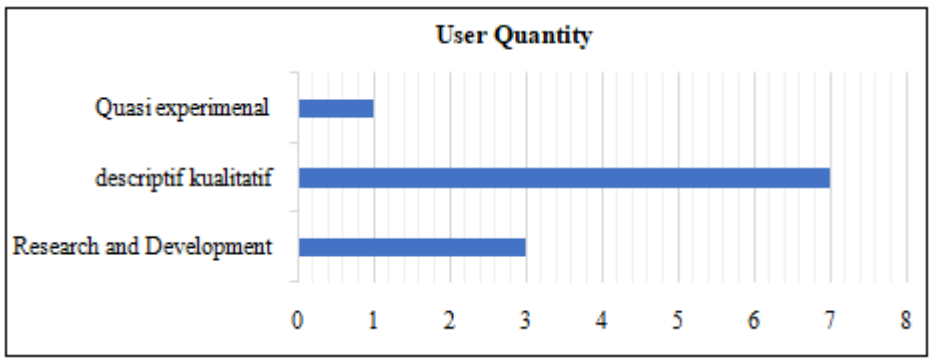

Figure 3: Diversity of Research Methods

Figure 3 shows that the majority of researchers use qualitative descriptive research as their method. This condition allows for further exploration of various other methods that are suitable for the characteristics of ethnoscientific research.

4. Research Findings

The results or findings of a research study determine the quality of a research topic. If the research findings contribute positively, they can generate new interest in the topic among both related and unrelated researchers. The focus of discussion in this study is on findings related to variables that support quality physics learning, such as character, critical thinking, collaborative learning ability, media, conceptual understanding, and others. The trends in research findings from the 11 articles analyzed in this study are summarized in the following table (Table 2).

No	Researcher	Year	Results/Findings
1	KC Moro, WJSM Billote	2023	• Improving understanding of physics concepts • Enhancing student motivation to learn • Fostering positive attitudes among students • Not successful in fostering students' scientific curiosity
2	H Nuroso, Supriyadi, S. Sudarmin&Sarwi	2019	• Indigenous science exists in the process of making bricks, which includes material preparation, molding, drying, firing, and quality testing of bricks. • This finding can be integrated into Environmental Physics courses (as a learning resource and media)
3	R D Handayani, I Wilujeng, Z K Prasetyo Triyanto & MA Tohir	2019	• Indigenous Knowledge is related to the concept of thermal physics (as a learning resource). • Indigenous Knowledge contains life values (character values, as a learning resource)
4	Yuni Ratnasari, Anti Kolonial Prodjosantoso, Dadan Rosana, Irwanto Irwanto	2020	• Local community activities in producing Jepara sculptures, Kudus sweets, Batik Bakaran, and Rembang salt are related to the concept of physics. • Physics concepts are related to local knowledge, including changes in state, conductors and insulators, and heat transfer (as learning resources, as media)
5	WN Azmy, H Kuswanto	2021	• Traditional game comics (such as bola kasti) are highly effective as learning resources and media. • They foster positive responses in students.
6	P Parmin, P Nuangchalerm, R. Ahmad Zaky El Islami	2019	• Indigenous Knowledge dengan menggunakan model SIL efektif untuk pengembangan konten sains (sumber belajar).
7	RF Sidik, WP Hadi	2019	• Eight indigenous knowledge related to salt production were found that can be reconstructed into scientific knowledge (Scientific Process, sources, and media).
8	ANW Priyadi, H Kuswanto	2021	• A suitable and effective comic product has been produced for use in physics education, specifically for the topic of work and energy (media, learning resource)
9	SN Izzah, S Sudarmin, APB Prasetyo	2020	• Reconstructed scientific knowledge has been discovered from indigenous science in the process of batik making, which can be integrated into science education using the STEM approach (scientific process, source, media).
10	L Heliawati, L Lidiawati	2022	• Improve students' scientific literacy.
11	P Parmin, M Taufiq	2020	• The mapping results indicate that some local knowledge has the potential to be scientifically tested in laboratories, such as Bakar Batu, Tanam Sasi, and Honai in Papua; Rumoh Aceh and Batu Nisan in Aceh; Berjuluk Baatutuk and Betang Radang in West Kalimantan; as well as Ebang and Welang in East Nusa Tenggara (myths and legends excluded). • The mapping of local knowledge has increased the interest of prospective science teachers in studying ethnosciences (Learning interest, scientific sublime). • The unique local knowledge of communities in remote and underdeveloped areas (3T) needs further scientific investigation and can be studied as a source in Ethnosciences courses.

From Table 2, it is evident that research on indigenous knowledge generally has a positive impact on physics education. It has been found to improve various quality variables in physics education. Based on the findings in this study, the following quality variables have been successfully enhanced: diversity of learning resources and media, learning motivation, understanding of scientific concepts, learning interest, and scientific sublime. However, the research conducted by Moro and Billote (2023) did not succeed in enhancing scientific sublime. This presents an opportunity for future researchers to take strategic steps to ensure that similar research can effectively improve students' scientific sublime in physics education.

5. Conclusion

Based on the analysis of the 11 articles, it can be concluded that the integration of indigenous knowledge in physics education has a positive impact on students. The analysis results indicate that the research has a positive effect on various quality variables in science/physics education, such as enhancing the diversity of learning resources and media, improving learning motivation, increasing understanding of scientific concepts, fostering learning interest, and enhancing scientific sublime. The analysis also reveals that there is a need for further research on indigenous knowledge, particularly in various regions in Indonesia, including the 3T regions (frontier, outermost, disadvantaged), using more diverse research methods.

6. Future Scope

Considering the conclusions drawn, research has great potential to be developed in advancing physics education, especially in Indonesia, particularly in the province of East Nusa Tenggara where the author is based. This is because there is currently no research on indigenous knowledge - based physics education in that region.

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